SCIENCE

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THE LIFE AND WORK OF DR. GOULD.

SOMEWHAT more than a week has passed since the sods were placed over the honored grave of Dr. Gould, yet even in the busy haste of our American life there are many who will welcome an appreciative account of the life and achievements of this eminent astronomer. So many notices of him were printed in the daily journals, immediately after the community was apprized of its sad loss, that it is unnecessary here to recount the details of his work. But it may be of service to give, in right perspective, a just idea of the magnitude and character of his contributions to astronomy, to speak of the purpose and importance of what he accomplished for science, and of the nature of his strong personal influence in its advancement.

Considered apart from the great things he accomplished, the first thing that strikes us about his career is the intimate way in which it is bound up with the history of his beloved science on both sides of the Atlantic, and the unique position he held, as illustrated by the number and extent of his personal alliances. It is scarcely possible to realize that he was the friend of von Humboldt, then in his 77th year; that it was due to the friendly interest of this great man, indeed, that he became the pupil, friend and intimate in the household of the great master of modern astronomy, Gauss, then in his 70th year; that he was the

pupil of the illustrious Encke, of the elder Struve, of Peters and Hansen and Argelander, and the life-long friend of these revered founders of modern astronomy. His correspondence with them after his return to his native land testifies to the mutual confidence that characterized these memorable associations. Following these, in the next generation, come Winnecke, Schönfeld, Auwers and a host of others, which to us are great names, but to Gould were fellow-pupils and associates. Of the same epoch, on this side the water, we have Bache, Peirce, Walker, Hubbard, Coffin, Chauvenet and Winlock. Then come the two existing generations of astronomers, bringing friendships and acquaintances wide as the world itself, extending his relations to the youngest workers in the science. With such universal and intimate connection with the personal forces operating to advance astronomy in all lands, with his intense patriotism, with his positive intellectual and moral traits, he could not fail to exercise a powerful moulding influence upon the development of American astronomy, in correcting wrong tendencies and establishing right standards. It was to this end, in preference to the satisfaction of ambition through what he could accomplish by his personal contributions to the fund of knowledge, that his most earnest efforts, from the beginning of his career, were directed. In one of his letters to von Humboldt, in 1850, after speaking of the dependent condition at that time of science here, its self-distrust and intellectual timidity, he says: "This I knew before returning home, but realize it now, for the first time, to its full extent. Therefore it is that I dedicate my whole efforts, not to the attainment of any reputation for myself, but to serving, to the utmost of my ability, the science of my country, or rather, as my friend Mr. Agassiz tells me to say, science in my country." And to Encke he says, speaking of the establishment of the *Astronomical Journal*, and his fond hopes in its agency as a means of raising the astronomy of America to its proper position: "Though the labor of supporting it will prevent me from working as I otherwise should for the advancement of my own reputation, still the consciousness that I may render now a still greater service to science reconciles me to the abandonment of a good deal of personal ambition." The same spirit breathes throughout his correspondence with Gauss, Schumacher and other leaders abroad, to whom he was wont to confide his projects and aspirations, and who sympathized with and counseeld him in return. His letter books are rich with similar illustrations. They form, indeed, a treasure house of information relating to the inner history of the beginnings of astronomy in the United States. How humble these beginnings were few realize. Astronomy here has made such wonderful strides within a few decades past that it is hard to believe that, with a few brilliant exceptions, its record about the year 1840 was practically blank. We had then no standing among the scientific nations. The soil for its growth was not indeed sterile, but its cultivation had scarcely begun. If the right seed had not been sown we should have had occasion to deplore to-day the same stunted crop which, even in some countries of far older civilization than ours, stands in place of the rich harvest that might have been gathered under more favoring influences. And this brings us to another remarkable feature of Gould's career. If we were asked to place the finger upon the one epoch marking the birth or regeneration of American astronomy, we should feel inclined to name the date, July, 1845, when Gould placed his foot upon the steamer from Boston with the avowed and definite purpose to devote himself to a life of purely scientific research. Up to that time the instance of a man doing this as

his only aim, while unassured of a professor's chair or similar appointment, and not as a means of livelihood, was in this country absolutely unknown. With a steadiness of purpose singular in so young a man, he pursued diligently the opportunity he had himself created—a year each at Berlin and Göttingen, and shorter periods at Altona, Gotha, Greenwich and Paris—and returned home, full of early honors and flushed with lofty hopes and honorable ambitions.

From this point Dr. Gould's life became one of incessant activity, impressing its mark in many ways upon the intellectual life of the community; but the line of intensest force naturally took the direction of his own beloved science, to which he communicated an impulse not measured merely by what he accomplished for it by his direct investigations, great as that is, but also by the force which always emanates from so earnest a nature as his. He inspired a new breath into American astronomy. The new atmosphere which he brought with him from Germany, where he had caught the spirit of the great masters under whom he studied, became gradually transfused upon this side the sea. His enthusiasm for the introduction of better means and methods of research was caught by his compatriots, their courage to regenerate our science was sustained, and transmitted through various channels to the next and to the present generation. Thus we may say, without fear of being controverted, that American astronomy to-day is a different thing from what it would have been without Gould's predominant influence, deep and quiet but strong, to upbuild it and to free it from the clumsiness and imperfections which still impede it even in some of the otherwise most enlightened nations of the world. It is under his leadership that American astronomy has climbed to where it looks with steady and level eye upon that of Germany, which occupies perhaps a larger but not a loftier plain. It is his example which will stimulate it, in its upward course during the new century nearly upon us, to attain first, in the friendly and honorable national rivalry, the heights commanding all. We cannot presume to say how far the good fortune which has secured our astronomy so exalted a place has been shared by other branches of physical or of natural science in our land; or, if so, whether it can be traced to any similar instrumentality. But there can be no doubt that, so far as astronomy is concerned, this enviable position has been reached, and that among the personal influences contributing to that result Gould's may be justly regarded as preeminent.

Let us now glance at Dr. Gould's more prominent labors, passing by his earlier important investigations in applied theoretical and in practical astronomy, as well as his numerous and valuable contributions to the literature of science, education and other departments of thought, which we find scattered through the long range of his career.

In 1852 he was appointed to take charge of the longitude determinations of the Coast Survey. He organized, developed and extended his service, retiring in 1867. Meanwhile, in 1855, he became Director of the Dudley Observatory in Albany, equipped and organized the institution, and carried it on without remuneration and at his private expense. He left it in 1859, after a severe struggle to preserve the institution for purposes of scientific investigation.

In 1859 he published his discussion of the places and proper motions of circumpolar stars, for use as standards in the Coast Survey. These, as revised by him in 1861, together with his similar list of clock stars, were adopted as the standards for the American Ephemeris, and, as to the circumpolars, remain in such use to this day. In

1866 he published his reduction of D'Agelet's observations. About the same time he performed a similar service for the greater part of the observations made at the United States Naval Observatory since its establishment, as he had done also several years previously for the expedition to Chili to determine the solar parallax. In 1866 he planned and executed the work of establishing, by the Atlantic cable, the relation in longitude between European and American stations, involving, as a part, interesting researches on the velocity of the galvanic current in submarine cables, similar to those he had already made on land lines.

As actuary of the United States Sanitary Commission, he conducted, and published in a large volume, extensive and important researches upon Military and Anthropological Statistics and the Distribution of Population. About the same time he undertook the reduction of Rutherfurd's photographs of the *Pleiades*. The results, partially published in 1866, were submitted completely, in an elaborate memoir, to the National Academy in 1870, together with a second memoir on the *Præsepe*. He was, indeed, a pioneer in the utilization of photography for exact astronomical measurement. About 1864 he built an observatory in Cambridge, equipped with an 8-ft. transit instrument, and, until 1867, carried on a determination of the right ascensions of all the stars to the tenth magnitude within one degree of the pole. This work was completely reduced, but the discussion and publication were postponed by his removal to Cordoba.

In 1865 he became intensely impressed with a desire to explore the southern celestial hemisphere. The opportunity to do so soon came. This project assumed at first the form of a private astronomical expedition, for which his friends in Boston had promised the pecuniary means; but, under the enthusiastic support of Mr. Sarmiento, at first as Argentine Minister to this country, and later as President of that Republic, it rapidly broadened, and finally led to the establishment, by Dr. Gould, of a permanent National Observatory at Cordoba. This marks an epoch in modern astronomy, the equalization of our knowledge of the two celestial hemispheres. The institution and its work form an impressive monument to his memory.

It is impossible, in brief space, to describe or characterize the marvelous work here undertaken and so faultlessly pushed to completion by Dr. Gould, during the fifteen years of self-imposed exile from his native land, with unfaltering devotion and energy, in the face of difficulty and domestic bereavement. The work on the uranography of the southern heavens was finished in 1874, and was published under the title of the *Uranometria Argentina*, which will remain a classic for all time. The zone-observations of the stars between 23° and 80° south declination, which were the original and always the dominant object of the enterprise, were begun in 1872, substantially completed in 1877, and revised in 1882–83. This work was embodied in the Zone-Catalogues containing 73,160 stars, which appeared in 1884. Parallel with this, and almost overshadowing it in importance, was carried on the independent series of meridian circle observations for the General Catalogue of 32,448 stars, completed in 1885. Dr. Gould, besides, left the manuscript of the remainder of his series of fifteen volumes, not then published—containing the observations and the annual catalogues, incorporated in the General Catalogue—complete to the minutest detail, ready for the printer. These have since appeared from time to time; the last volume, rounding out his work, reaching Cambridge but a few hours before his death.

Another part of the work for the Cordoba Observatory, planned by Dr. Gould as a fitting extension of it, was a *Durchmusterung*

of the southern sky. For this, indeed, he had provided the instrumental means and trained the assistants, it being his purpose to be ready to begin it at any time in case of unforeseen delay or accident to the other work. On leaving Cordoba he confined it to the care of Dr. Thome and Mr. Tucker, who have since so worthily conducted it.

Dr. Gould also established, under the auspices of the Argentine government, a meteorological service, second in extent, it is believed, only to that of the United States. Upon leaving South America he intrusted this charge to the hands of his worthy successor, Walter G. Davis.

The earliest to recognize and demonstrate the capabilities of photography to render service to the astronomy of precision, Dr. Gould, by his experience with the Rutherfurd plates of the *Pleiades* and the *Præsepe*, was incited to arrange to carry forward at Cordoba, on an extensive scale, a similar work upon the southern stellar clusters. His other labors there were so onerous that he confined his attention to securing plates suitable for precise measurement. Of these he accumulated about 1,400, and brought them home with him for measurement and reduction. Without permitting himself a well-earned retirement, he turned at once, tirelessly, to this labor, which has been the principal occupation of the last ten years of his life. This is substantially complete, and will be given to the world as it came from his hand.

Dr. Gould had an enthusiasm for the advancement of his beloved science far wider than the limits of what he could by personal investigation accomplish. Early in his career he keenly realized that astronomy had reached a stage of development in America which entitled it to a higher claim than had yet been accorded to it, and that a journal worthily supporting the dignity of a pure science would have very great influence upon its future progress. Accordingly, without ostentation, he established the *Astronomical Journal* in November, 1849, offering it to the use of astronomers, for the publication exclusively of original investigations. He edited and supported it until, at the end of the sixth volume, in 1861, its issue was suspended, first by the war for the preservation of the Union, afterward by his absence in Cordoba. A long nurtured hope was realized when he was enabled, in 1885, to resume its publication and to continue it, at the rate of nearly one volume annually, to the present time. Of all the great enterprises of his life, this is the one which he has most cherished. With careful forethought, he has made due provision for its continuance.

Dr. Gould was born in Boston, September 27, 1824. He entered the Boston Latin School in 1836, and graduated from Harvard College, with high distinction in classical as well as in mathematical and physical studies, in 1844.

He married, in 1861, Mary Apthorp Quincy, daughter of the Hon. Josiah Quincy. She died in 1883. Her sympathy with and influence upon his life-work may be most reverently spoken of by recalling the lines of his dedication of the Zone Catalogue:

"This Catalogue of Southern Stars, the fruit of nearly thirteen years of assiduous toil, is dedicated to the beloved and honored memory of Mary Apthorp Quincy Gould, to whose approval and unselfish encouragement the original undertaking was due, by whose sympathy, self-sacrifice and practical assistance its execution was made possible, who bravely endured privation, exile and afflictive bereavement that it might be worthily finished, but who has not seen its completion."

Dr. Gould received the degree of Ph.D. from Göttingen in 1848, and that of LL.D. from Harvard in 1885, and from Columbia in 1887. During his illustrious career he

was the recipient of the highest honors that Europe has to bestow, to an extent scarcely vouchsafed to any other American. A few only will be named here: Mem. Roy. Soc. (London); For. Assoc. Roy. Astr. Soc. (London); Cor. Mem. Acad. Sci. (Institut de France); Acad. Imp. Sci. (St. Petersburg); Kön. Akad. Wiss. (Berlin); Kön. Ges. Wiss. (Göttingen); Kais. Akad. Wiss. (Vienna); Bur. d. Long. (Paris). He was also knighted, of the Order Pour le Merite, by the German Empire, a distinction never given to any other American and exceedingly rare even in Europe.

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THE INFLUENCE OF LIGHT ON THE DISCHARGE OF ELECTRIFIED BODIES. II.

CONNECTION BETWEEN PHOTO-ELECTRIC SENSITIVENESS AND ABSORBING POWER. WORK OF STOLETOW, HALLWACHS, ETC.

58. The fact that water is an inactive substance as regards the negative discharge was shown by Bichat and Blondlot* by means of an apparatus similar to that used by Righi. Instead of a metal plate a sheet of glass was used, over which a stream of water was allowed to flow. In front of this was placed a wire gauze. It was impossible to obtain any current between water and gauze by illumination, even when 80 cells were used. The authors point out that water is transparent to the effective rays, as first shown by Hertz.

59. Stoletow† used a method similar to that of Bichat and Blondlot with various colored liquids, such as solutions of Fuchsin, Eosin and Fluorescin in ammonia. He came to the conclusion that the effect was always greatest in those liquids which were *capable of absorbing the active rays.*

60. This conclusion was in the main confirmed by Hallwachs* by more reliable and systematic methods. The liquids to be tested were placed in a rather large watch glass, and were illuminated by an arc light placed vertically above the surface. A screen of quartz or gypsum was placed beneath the lamp to prevent disturbance from carbon particles. Connection was made between the liquid and the electrometer by a platinum wire, and the effect of illumination was measured by the rate of dissipation a negative charge on the liquid surface.

Some of the results are given below:

Aqueous solutions of Fuchsin, Cyanin	as sensitive as metals
Aqueous solutions of KNO_3, Eosin, Haematoxylin, Aniline	less sensitive
Water, Solutions of Chromic acid, Potassium permanganate, $Co(NO_3)_2$, KNO_3, KBr, Acetone, Amylacetate	no effect

61. Some trouble was experienced on account of the irregularity of the arc lamp. In order to be able to obtain at any time a measure of its intensity, a piece of copper, which had been oxydized by being brought to a red heat, was kept at a fixed distance from the arc, and the rate of negative discharge from its surface measured from time to time. Such a surface is much less sensitive than one that is polished and clean, but it appears also to be more permanent.

62. Hallwachs gives one series of observations showing the influence of the concentration of the solution. It appears that the intensity of the effect increases less rapidly than the concentration.

63. A consideration of the results showed that all the liquids which were sensitive to the influence possessed a strong absorbing power for ultra-violet rays. The connection between absorption and sensitiveness for the effect does not, however, appear to be a

* C. R. 106, p. 1349. Beibl. 12, 605.

† C. R. 106, p. 1593. Beibl. 12, 723.

* Wied. Ann. 37, p. 666.